

REMARKS

The Office Action of October 7, 2003 presents the examination of claims 1-19 and 34-36. New claims 37 and 38 are added herein. Previous grounds of objection and rejection, except for prior art, have been withdrawn.

Support for new claims 37 and 38

Support for new claims 37 and 38 is provided, e.g. by the Examples 1 and 2, in which a viologen salt is synthesized on a LDPE substrate and then a PANI coating is synthesized *in situ* by persulfate induced polymerization of aniline. See also page 10, lines 15-32.

Rejections over prior art

The Examiner has maintained the following rejections under 35 USC § 103(a) :

Claims 1, 2, 10, 11 and 17 over Mikhael '017 in view of Porter '621;

Claims 1, 2, 7-11, 15, 17-19 over Afzali-Ardakani '370 in view of Porter '621 and Renbaum '055;

Claims 3-6 over Afzali-Ardakani in view of Porter '621, Renbaum '055 and Beratan '063;

Claims 12-14 and 16 over Afzali-Ardakani in view of Porter '621, Renbaum '055 and Inata '062; and

Claim 34 over Afzali-Ardakani in view of Porter '621, Renbaum '055 and Allemand '379.

The Examiner makes the following new rejections under 35 USC § 103(a) :

Claim 35 is newly rejected under 35 USC § 103(a) as being unpatentable over Afzali-Adakai '370 in view of Porter '621, Renbaum '055 and Beratan '063, in further view of Moshtev '623 and Spence '355.

Claim 36 is newly rejected under 35 USC § 103(a) as being unpatentable over Afzali-Adakai '370 in view of Porter '621, Renbaum '055 and Beratan '063, in further view of Pohl '233.

All of these rejections are respectfully traversed. Reconsideration and withdrawal thereof are requested.

Applicants again submit that the Examiner has failed to establish *prima facie* obviousness of the claimed invention. In particular, there is not proper motivation to combine the references in the manner that the Examiner does and, especially with respect to claims 34-36, the combined references do not provide each and every element of the claimed invention.

Furthermore, even if the Examiner's case of *prima facie* obviousness is accepted, Applicants provide here evidence, in the form of a Declaration of Ms. Xin Liu, which establishes unobviousness of the claimed invention.

The Claimed Invention

The claimed invention is a method for making an electrically conductive polymeric material. The first independent claim recites a step of contacting a polymeric material with a viologen salt, in which the polymeric material is one that can exhibit electrical conductivity upon oxidative doping. The second step of the first independent claim recites irradiating this composition with electromagnetic (EM) radiation to produce an electrically conductive polymer. Dependent claims 2-19 variously limit the wavelength of the EM radiation, the manner of contacting the viologen salt with the polymeric material, the chemical nature of the viologen salt, the chemical nature of the polymeric material, the rate at which the polymeric material acquires conductivity, or the processing conditions. Dependent claims 34-36 describe methods in which the viologen is polymerized upon a substrate which is then contacted with the polymer, or in which the viologen is polymerized upon the polymer itself.

The teachings of the cited references

Mikhael '017 describes a method for making a conductive polymeric material by contacting a polymeric material with a quinone compound and irradiating that composition with ultraviolet light. The Examiner generalizes Mikhael to encompass use of any

organic substance that interacts with or complexes with any organic donor material.

Closer reading of Mikhael shows that the reference describes the making of a polymer composite that has conductive properties due to inclusion of electron acceptor dopants and an electron donor substance, which are embedded in a polymer matrix. (See, col. 3, lines 17-20.) In both cases, the dopants are non-ionic organic molecules. (See, col. 3, lines 45-48.)

Porter '621 describes a process for the photo-oxidation of water using a manganese (II) or manganese (III) complex as a catalyst. Electron acceptors suitable for use in Porter's invention are those "sufficiently powerful ... to abstract electrons from the excited manganese complex." Quinones and viologens are described as suitable electron acceptors. Upon photoirradiation, the manganese complex is oxidized to Mn(IV) and the electron acceptor is reduced. In the second half of a cycle, the electron acceptor is reoxidized and the Mn complex returns to the Mn(II) or (III) state. (See, col. 4, line 64 to col. 5, line 7.)

Afzali-Ardakani '370 describes doping of polyaniline polymers with charge transfer complexes. The complexes are formed by treatment of polyaniline with quinones or derivatives thereof as electron acceptors. The process is enhanced by addition of protonic acids to the solution of the quinones. (See col. 3, lines 39-67.)

Renbaum '055 is cited for the teaching of grafting of a quaternary vinyl pyridine onto a substrate using "radiation". Renbaum describes use of gamma radiation, which the Examiner asserts is well-known to be equivalent to use of ultraviolet radiation. Renbaum describes the product of such a grafting as cross-linked.

Beratan '063 describes an electron shift register memory in which electrons are transferred between a methyl viologen material and a polyaniline material via a ruthenium-bipyridine complex. The electron shift is photoinduced. (See col. 6, lines 16-30.)

Inata '062 describes various viologen and viologen-salt materials.

Allemand '379 describes an electrochromic device that is made up of alternating layers of "electrochemically active" polymers and electrolytes disposed between two electrodes. Allemand '379 describes in Example 1 the preparation of polyaniline on a substrate *in situ* by polymerization of aniline with ammonium persulfate on a conducting glass substrate. In Example 4, Allemand '379 further describes making an electrochromic cell using a second piece of conducting glass and filling the cell with ethyl viologen perchlorate solution. No irradiation step is described in this example. In Example 9, liquid polyaniline is mixed with ethyl viologen triflate and a radiation curable acrylated epoxy urethane. The mixture is irradiated to form a solid composite.

Moshtev '623 describes a method for making membrane battery separators that employs grafted LDPE substrates.

Spence '355 describes electrodes and methods for using them in gas discharge plasma grafting of polymers. Spence notes LDPE as a material that can be used in the method.

Pohl '233 describes grafting of vinyl benzyl groups onto an ethylene, vinyl acetate copolymer using gamma irradiation.

Differences between the Invention and the prior art

**As to claims 1, 2, 7-11, 15 and 17-19**

As explained above, claim 1 describes the invention as a method of making an electrically conductive polymer by contacting a polymeric material that can be made conductive by oxidative doping with a viologen salt and irradiating the composition. The rejection of claim 1, and claims dependent thereon, over the combination of Mikhael and Porter, or Afzali-Ardakani, Porter and Renbaum fails because the combined references to not describe or suggest each and every element of the claimed invention.

Mikhael discloses making a three component composition that is a non-conductive polymer that is doped with an electron donor organic molecule and an electron accepting organic molecule. The process of Mikhael is distinct from the present invention first in that the presently claimed process uses viologen salts rather than quinones as described by Mikhael. Second, the result of the

instantly claimed process is a polymeric material that is conductive per se, rather than a material that relies upon embedded charge-carrying doping materials to conduct charges. Thus, the quinones described by Mikhael accept electrons from the organic molecule donor, a different kind of molecule such as anthracene or polyaniline, and then pass them on to another such organic donor molecule to conduct charge. On the other hand, the result of the process of the present invention is that the polymeric material, such as an oxidized polyaniline itself, conducts charge by a mechanism wherein one molecule of the oxidized polyaniline receives an electron to another molecule of polyaniline. The Examiner might further note that the radiation curable monomers described by Mikhael are not such as to become conductive per se upon irradiation.

Porter fails to remedy these deficiencies of Mikhael. The Examiner cites Porter as teaching equivalence of viologen and quinones as oxidation reagents. However, while Porter does teach equivalence of quinones and viologens as oxidants of manganese pyrrole complexes, there is no teaching by Porter that quinones and viologens are equivalent in their ability to oxidize a polyaniline compound, or any other polymer, so as to make it conductive. Accordingly, Porter does not provide the motivation asserted by the Examiner to modify Mikhael by substituting a viologen salt for a quinone as an oxidant of a polymeric material. See, *In re Jones*,

21 USPQ2d 1941 (Fed. Cir. 1992). Alternatively, as the splitting of water is far afield from making a conductive polymer, such that the skilled artisan would not likely consider teachings of how to split water relevant to learning how to oxidatively dope a polymer, Porter may be considered as non-analogous art and therefore inclusion of that reference in making a rejection for *prima facie* obviousness is improper. *In re Oetiker*, 24 USPQ 1443 Fed. Cir. 1992).

Furthermore, the references being cited must be considered as a whole, and the combination of the references cannot change the principle of operation of the references. *W.L. Gore & Assoc. v. Garlock, Inc.*, 220 USPQ 303 (Fed. Cir. 1983) and *In re Ratti*, 123 USPQ 349 (CCPA 1953). The combination of Mikhael with Porter would result in a process that relies upon the presence of some manganese complex and such is not present in the instantly claimed invention. Therefore the combination of the references as suggested by the Examiner would change the basic principle of the Porter reference and so the combination of Mikhael and Porter does not properly establish *prima facie* obviousness of the claimed invention.

Furthermore, Porter provides no disclosure or suggestion that the polymeric molecule *per se* should become conductive. In the instant invention, the resulting polymeric material is one in which the polymeric material *per se* is oxidized and anions of the viologen salt are incorporated and serve as counter ions to the

oxidized polymer. See page 7, last paragraph, of the specification.

The Mikhael and Porter references are not properly combinable. Furthermore, the combination of Mikhael and Porter fails to provide each element of the claimed invention. Also the motivation to modify the teachings of Mikhael by substituting a viologen salt for the quinone as an oxidant of the polymeric material is not provided by Porter. For any or all of these reasons, the Mikhael and Porter references fail to establish *prima facie* obviousness of the invention and the instant rejection of claims 1, 2, 10, 11 and 17 under 35 U.S.C. § 103(a) over Mikhael in view of Porter should be withdrawn.

Similarly, Afzali-Ardakani, combined with Porter and Renbaum, fail to describe each element of the invention set forth in claims 1, 2, 7-11, 15 and 17-19. Furthermore, there is no motivation to combine the references in the manner suggested by the Examiner. Thus, this combination of references fails to establish *prima facie* obviousness of the claimed invention.

As explained above, Afzali-Ardakani describes doping of a polyaniline material with electron acceptors to form charge-transfer complexes. The electron acceptors are quinones or derivatives such as tetracyanoquinodimethane. There is no mention in Afzali-Ardakani of any irradiation step. The only processing step introducing the electron acceptor disclosed is immersion of

the polyaniline material in a solution of the electron acceptor with or without the addition of protonic acids.

Porter does not remedy these deficiencies of Afzali-Ardakani. For all of the reasons explained above, Porter does not disclose or suggest use of a viologen salt to oxidize a polymeric material and make it conductive.

Renbaum also does not describe any oxidation of a polymeric material by irradiation of the polymer in the presence of an oxidant. Renbaum discloses a grafting reaction that is driven by irradiation with gamma radiation. This is distinct from a photo-oxidation of a polymeric material. Renbaum may be relevant to the processing conditions of claim 19, but makes no teaching or suggestion of the process steps of claim 1. Thus, even as to claim 19, at least one process step is omitted by the combination of Afzali-Ardakani, Porter and Renbaum.

Furthermore, the attached Liu Declaration provides evidence that certain ways of contacting the viologen salt with the polymeric material provide unexpected results to the claimed method. In particular, the Liu Declaration shows that when the viologen salt is synthesized *in situ* upon a substrate and then contacted with the polymeric material, the polymeric material acquires conductivity that is greatly enhanced, by a factor of from  $10^5$  to  $10^6$ , compared to the conductivity achieved in a process in which an already formed viologen salt is grafted to the substrate.

Ms. Liu states that the overall conductivity of the material obtained using the grafted viologen is poor because of extensive cross-linking of the viologen. Ms. Liu also explains that *in situ* synthesis of the viologen avoids such cross-linking. This point is especially relevant to claims 5 and 34-36.

On the other hand, the Renbaum reference cited by the Examiner for the proposition that quaternized vinyl pyridine can be grafted onto a substrate by [gamma] radiation describes that the resulting product is a cross-linked one. See, col. 1, line 65. Thus, the Liu Declaration establishes that the present invention is patentable at least over combinations of references that include Renbaum.

The teachings of Spence asserted by the Examiner, to the effect that UV and gamma radiation are equivalent for purposes of grafting reactions, are similarly irrelevant to claim 1 and Spence thus also does nothing to remedy the failure of Afzali-Ardakani and Porter to establish *prima facie* obviousness of the claimed invention.

As to claim 18 specifically, the Examiner takes a position that the rate of decline in resistance is inherent in the structure of the composition ("identical or substantially identical structures would have identical or substantially identical properties"). However, the present claims are not directed to a structure, but rather to a process and the process steps of the

instant claims are distinct from those described by Afzali-Ardaki and Porter. In particular, Afzali-Ardakani describes doping of the polymeric material by immersion in a solution of the doping organic molecule, while the instant claims recite oxidative doping by irradiation of a viologen salt in contact with the polymeric material. There is no basis for the Examiner to suppose that a similar rate of decline in resistance would be obtained by the process of the present invention and that of Afzali-Ardakani, whether or not modified by the teachings of Porter. Indeed, the evidence provided in the attached Liu Declaration establishes that the process for grafting the viologen salt to the substrate greatly influences both the degree of resistance decline and its rate. Therefore, processing steps have a clear influence on the properties of the resulting product. Thus, the distinction between oxidative doping by irradiation and molecular doping by immersion would be expected to provide different results, not identical results as asserted by the Examiner.

For all of the above reasons, the combination of Afzali-Ardakani, Porter and Renbaum or Spence does not establish *prima facie* obviousness of the invention recited in claims 1, 2, 7-11, 15 and 17-19 and the rejection of these claims under 35 U.S.C. § 103(a) over those references should be withdrawn.

**As to claims 3-6**

Claims 3-6 are dependent from claim 1. As explained above, the invention as recited in claim 1 is not described or suggested by the combination of Afzali-Ardakani together with Porter and Renbaum. The Examiner notes that these references also fail to describe that a viologen salt is deposited on a substrate and cites Beratan as describing this limitation.

As noted above, Beratan '063 describes an electron shift register memory in which electrons are transferred between a methyl viologen material and a polyaniline material via a ruthenium-bipyridine complex. The electron shift is photoinduced. (See col. 6, lines 16-30.) Thus, Beratan does nothing to remedy the failure of the combination of Afzali-Ardakani, Porter and Renbaum to describe the fundamental invention as recited in claim 1, from which claims 3-6 depend. The instant rejection thus fails because every element of the claimed invention is not described or suggested by the cited references.

Furthermore, combination of Beratan with Afzali-Ardakani, Porter and Renbaum is inconsistent with the recitations of the present claims 3-6. References must be considered as a whole. *W.L. Gore & Assoc. v. Garlock, Inc.*, 220 USPQ 303 (Fed. Cir. 1983) The combination of references cannot result in change in the basic principles taught by the references. *In re Ratti*, 123 USPQ 349 (CCPA 1953).

In the present instance, inclusion of the Beratan reference would result in a process that relies upon a ruthenium-pyridine complex to effect transfer of charge from the viologen salt to the polymeric material. Thus, combining Beratan with Afzali-Ardakani and Porter would require a ruthenium-pyridine complex to be a part of the present invention and such is not so. Thus, inclusion of Beratan among the references in the manner suggested by the Examiner requires changing the basic principle of the Beratan reference to achieve the invention. Therefore, including the Beratan reference in the instant rejection is improper and an obviousness rejection relying upon Beratan must fail.

For all of the above reasons, the combination of Afzali-Ardakani, Porter, Renbaum and Beratan fails to establish proper *prima facie* obviousness of the invention of claims 3-6. Therefore, the rejection of claims 3-6 over those references should be withdrawn.

***As to claims 12-14 and 16***

Claims 12-14 and 16 are dependent from claim 1. As explained above, the invention as recited in claim 1 is not described or suggested by the combination of Afzali-Ardakani together with Porter and Renbaum. The Examiner notes that these references also fail to describe that the viologen salt used is polymeric, or that the viologen moiety is present in the backbone or in the side chain of the polymer. Inata is cited for the latter propositions.

As noted above, Inata merely discloses various viologen compounds, including a polymeric viologen. Thus, Inata does nothing to remedy the failure of the combination of Afzali-Ardakani, Porter and Renbaum to describe the fundamental invention as recited in claim 1, from which claims 12-14 and 16 depend. The instant rejection thus fails because every element of the claimed invention is not described or suggested by the cited references. Accordingly, the rejection of claims 12-14 and 16 under 35 U.S.C. § 103(a) over those references should be withdrawn.

***As to claim 34***

Claim 34 is ultimately dependent from claim 1. As explained above, the invention as recited in claim 1 is not described or suggested by the combination of Afzali-Ardakani together with Porter and Renbaum. The Examiner notes that these references also fail to describe that a substrate for depositing a polymeric material (polyaniline) should be low density polyethylene. Moshtev and Spence are cited for this proposition. The Examiner also notes that the combination of Afzali-Ardakani, Porter and Renbaum fails to describe in situ formation of polyaniline on a substrate by reaction of aniline and ammonium persulfate; Allemand is cited for this element of the present invention.

Even if the Examiner's interpretation of Moshtev, Spence and Allemand is accepted, these references do nothing to remedy the failure of the combination of Afzali-Ardakani, Porter and Renbaum

to describe the fundamental invention as recited in claim 1, from which claim 34 depends. The instant rejection thus fails because every element of the claimed invention is not described or suggested by the cited references. Accordingly, the rejection of claim 34 under 35 U.S.C. § 103(a) over those references should be withdrawn.

***As to claim 35***

Claim 35 is ultimately dependent from claim 1. As explained above, the invention as recited in claim 1 is not described or suggested by the combination of Afzali-Ardakani together with Porter and Renbaum. The Examiner notes that these references also fail to describe that a substrate for depositing a polymeric material (polyaniline) should be low density polyethylene. Moshtev and Spence are cited for this proposition. The Examiner also notes that the combination of Afzali-Ardakani, Porter and Renbaum fails to describe formation of the viologen salt upon the substrate by reaction of vinyl alkyl halide or vinyl benzyl halide grafted substrate with 4,4' bipyridine and then with alkyl halide. The Examiner asserts that such a reaction is well-known to the skilled artisan.

Even if the Examiner's interpretation of Moshtev and Spence, and his position about the knowledge of the skilled artisan is accepted, these references do nothing to remedy the failure of the combination of Afzali-Ardakani, Porter and Renbaum to describe the

fundamental invention as recited in claim 1, from which claim 35 depends. The instant rejection thus fails because every element of the claimed invention is not described or suggested by the cited references. Accordingly, the rejection of claim 35 under 35 U.S.C. § 103(a) over those references and the Examiner's assertion should be withdrawn.

Furthermore, Applicants submit that the Examiner is improperly using hindsight reconstruction of the invention using the present claims as a template upon which to assemble elements of the prior art. This is easily seen by the Examiner's reliance upon an assertion that a particular synthetic reaction is "well-known in the art". Where is the motivation to select such a reaction from among the hundreds of thousands of "well-known" synthetic reactions to apply it to the present invention? Applicants submit that there is none. The requirement for showing motivation to modify the teachings of the prior art is expressly to prevent the improper hindsight reconstruction of the invention employed by the Examiner in making the instant rejection. *In re Fine*, 5 USPQ2d 1596 (Fed. Cir. 1988). As such is absent, the instant rejection is improper and should be withdrawn for this additional reason.

Furthermore, as shown by the attached Liu Declaration, the manner in which the viologen salt is attached to the substrate influences the properties of the resulting conductive polymeric material. The manner in which the material is produced as

described in claim 35 provides an unexpectedly superior product. The evidence of the Liu Declaration establishes unobviousness of the invention as claimed in claim 35 and the instant rejection should be withdrawn for this additional reason.

***As to claim 36***

Claim 36 is ultimately dependent from claim 1. As explained above, the invention as recited in claim 1 is not described or suggested by the combination of Afzali-Ardakani together with Porter, Renbaum and Beratan. The Examiner notes that these references also fail to describe that the viologen salt is deposited on a suitable substrate by grafting vinyl benzyl chloride groups on a substrate using vinyl benzyl chloride, and then reacting the vinyl benzyl chloride groups with an equimolar mixture of 4, 4' bipyridine and p-xylene dihalide. Pohl '233 is cited for this teaching.

Even if the Examiner's interpretation of Pohl '233 is accepted, that reference does nothing to remedy the failure of the combination of Afzali-Ardakani, Porter, Renbaum and Beratan to describe the fundamental invention as recited in claim 1, from which claim 36 depends. The instant rejection thus fails because every element of the claimed invention is not described or suggested by the cited references. Accordingly, the rejection of claim 36 under 35 U.S.C. § 103(a) over those references should be withdrawn.

Furthermore, as shown by the attached Liu Declaration, the manner in which the viologen salt is attached to the substrate influences the properties of the resulting conductive polymeric material. The manner in which the material is produced as described in claim 36 provides an unexpectedly superior product. The evidence of the Liu Declaration establishes unobviousness of the invention as claimed in claim 36 and the instant rejection should be withdrawn for this additional reason.

Applicants submit that the present application well-describes and claims patentable subject matter. Withdrawal of the standing rejections and allowance of the present claims is requested.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Mark J. Nuell (Reg. No. 36,623) at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

Pursuant to the provisions of 37 C.F.R. §§ 1.17 and 1.136(a), Applicants respectfully petition for two (2) months extension of time for filing a response in connection with the present application. The required fee of \$210.00 is attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By   
Mark J. Nuell, #36,623

DRN/mua  
1781-0233P

P.O. Box 747  
Falls Church, VA 22040-0747  
(703) 205-8000

Attachment: Declaration under 37 CFR § 1.132